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ABSTRACT

To determine if imagery mediates memory for signs and words, 80 sign-language-fluent Ss -- half of whom were congenitally deaf and half of whom were normal-hearing -- were tested by varying the imagery values of stimuli. The relative efficacy of word and sign codes in processing and retrieving information was studied by systematically varying the mode of presentation and the mode of retrieval of information, thus producing four conditions of the experiment. sign-sign, sign-word, word-sign, and word-word. Among the findings were that there was an overall performance difference in recall between deaf and hearing students, with hearing Ss doing better than deaf Ss; and that, more importantly, there was an overall imagery effect which showed that imagery facilitated memory for words and signs for both deaf and hearing Ss. This facilitating effect was, however, absent in the word-sign condition for both groups. Findings suggested that words and signs are processed in a similar fashion. (Author/DLS)

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IMAGERY EFFECTS AND MEMORY FOR SIGNS AND WORDS

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ABSTRACT

Forty congenitally deaf students who had learned sign language before age 5 and 40 hearing fluent signers were tested to see if imagery mediates memory for signs and words by varying the imagery values of stimuli. The relative efficacy of word and sign codes in processing and retrieving information was studied by systematically varying the mode of presentation and the mode of retrieval of information. There were thus 4 conditions of the experiment, namely Sign-Sign, Sign-Word, Word-Sign and Word-Word. The recall data indicated that there were significant main effects for Groups and Imagery and a significant Imagery X Conditions interaction. Overall performance of hearing subjects was better than deaf subjects and high imagery items were recalled better than low imagery items in all conditions except the Word-Sign condition. Since there was no conditions main effect, results suggest that signs and words do not significantly differ in the way they are processed. The disappearance of the imagery effect in the Word-Sign condition may be due to a switch to a general semantic analyses strategy instead of an imagery strategy.

INTRODUCTION

Recent research has shown that ASL, which is used by many deaf people in America, is a language with its own grammar (Bellugi & Klima, 1975). Signed communication differs from auditory-spoken languages in that it is visual-manual. Studies on short-term memory processes of deaf people indicate that their mode of rehearsal seems to be mostly visual-kinesthetic and not acoustic (Conrad & Rush, 1965; Bellugi & Siple, 1971; Bellugi, Klima, & Siple, 1975). However, at the long-term memory level the organization of signs seems to follow semantic rather than visual-spatial principles (Siple, Fischer, & Bellugi, 1977). More studies are needed to compare how signs and words act in encoding and retrieving information from memory. Perhaps, the visual-spatial nature of signs makes them easier to process and remember like pictures. Perhaps due to the linguistic constraints, they may act just like words. One way to test these possibilities is to compare signs and words within the framework of dual coding theory (Paivio, 1971).

According to Paivio's (1971) dual coding theory, information is represented in a verbal and/or visual code in two independent but interconnected systems in long term memory.

When words can activate both codes they are remembered better than words which activate only the verbal code. The ease with which words can activate the visual code depends on the imageability of the referents. There are norms available on hearing students (Paivio, Yuille, & Madigan, 1968) which report scaled values on the imageability or imagery dimension of words. Using the words from this list which differ in their imagery values, studies have shown that high imagery words which presumably activate both codes are indeed remembered better than low imagery words (Paivio, 1971). This facilitatory effect of imagery on the memory for words has been reported for deaf students by Conlin and Paivio (1975). They selected

words which had varying values on imageability and signability dimensions and found a main effect for imagery for both deaf and hearing students and a main effect for signability only for deaf students. The latter result is not surprising considering that hearing students did not know sign language. Furthermore, a word high on the signability dimension was probably used more often because of its availability in sign communication and hence was remembered because of its familiarity value. Their results do not indicate how imagery influences memory for signs. Thus there is no study in the literature, to this date, which has directly tested for imagery effects in memory for signs.

The following experiment was designed to determine whether imagery mediates the processing and retrieving of signs and to test the relative efficacy of sign and word codes. If signs are processed like words, then the imageability of their referents will influence the processing and retrieval of information and thus a facilitatory effect of imagery should occur for both signs and words. However, if the visual-spatial nature of signs causes them to be highly encoded by the imagery system regardless of differences in the imageability of the underlying concepts referents, high-low imagery differences should not occur for signs. Secondly, information presented in signs should then be retrieved better than words just as pictures which get highly encoded by the imagery system are remembered better than words.

METHOD

Subjects: 40 students from the National Technical Institute for the Deaf (NTID), Rochester, NY, who were deaf from birth and had learned ASL before age 5 were tested. 20 were males and 20 were females. Out of 40, 8 had ASL speaking deaf parents and another 6 had deaf relatives. A majority of the deaf students (n = 34) went to residential schools for the deaf. Out of the remaining 6, 3 went to day schools for the deaf and 3 went to public schools for the hearing.

These students were matched in blocks for their scores on 3 language tests and 2 spatial ability tests. The language tests were the California Reading Comprehension Test, (READ) a subtest of the California Reading Tests, Junior High School Battery (Tiegs and Clark, 1963), the NTID Written Language Test (WRITE) - (Crandall, Note 3), and the Manual Reception Test (MRT), a subtest of the Test Battery of the C.I.D. Everyday Sentences List (Johnson, 1976). The spatial ability tests were the Spatial Relations Test (SRE), and the Abstract Reasoning Test (ABT) which are subtests of the Differential Aptitudes Test (Bennett, Seashore, & Wesman, 1966). Finally the students were also matched in blocks for the amount of hearing loss which was measured by the pure tone average (PTA) in the better ear at 500-1000-2000 Hz (ANSI, 1969). Subjects were then randomly assigned to 4 conditions of the experiment with the constraint that an equal number of males and females (5 each) were assigned to each condition and an equal number of deaf students born to deaf parents (2 each) were assigned to each condition. An analysis of variance of the data showed that the resulting 4 groups of subjects did not differ from each other on any of these tests. There were no significant sex differences on the tests. The overall scores of the deaf subjects on each test are reported in Table 1.

40 hearing people who were fluent signers and had a minimum of 1 year

of experience in signing were tested. These people were either interpreters who had completed the Interpreters Training program at NTID or the staff of NTID who were actively involved with deaf people. They were selected upon recommendation from the director of the Interpreters Training program. Out of 40, 8 were born of ASL speaking deaf parents, and another 5 had deaf relatives. The hearing signers were randomly assigned to the 4 conditions with the constraint that an equal number of males and females (4 males and 6 females) were assigned across conditions and an equal number of hearing signers born of deaf parents were assigned to each condition. At the time of testing a background information questionnaire was filled out by each subject which included information about their age, education, years of experience in signing, and their knowledge of ASL. An analysis of variance of the data showed that the hearing signers in the 4 groups did not differ from each other in age or experience in signing, and there were no sex differences. The mean age of the interpreters was 30.42 years with a standard deviation of 8.05, and the average years of signing experience were 12.82 with a standard deviation of 13.34. Chi-square tests on the data about education and knowledge of ASL showed that the groups did not differ from each other (Education: X^2:7.98, df :12 n.s.; Knowledge of ASL: X^2:7.62, df :6 n.s.).

Stimuli: The stimuli used in the study were selected from the data collected on deaf students at NTID on imagery values of nouns (Parasnis, Long, & Brown, Note 1; Parasnis, Note 2). These were considered easy to translate in signs and unambiguous in their meaning by 1 ASL speaker and 1 fluent signer. Of these 18 high and 18 low imagery nouns appeared on the presentation list. The average high imagery value of nouns was 6.78 with a standard deviation of .18 and the average low imagery value of nouns was 3.94 with a standard deviation of .73. The difference between the two was statistically significant (t:12.35, df:34, $p < .001$). All the nouns

were high frequency: A or AA according to the Thorndike and Lorge (1944) count. The word length of these nouns was controlled for high and low imagery words. The average length of the high imagery words was 5.38 letters (s.d.1.14) while for low imagery words it was 5.83 (s.d.1.85). The difference between the two was not significant (t:1.10, df:34, $p > .05$). The presentation list was arbitrarily divided into 3 parts of 12 items each and within each part an equal number of high and low imagery nouns were randomly assigned to the list positions. The list was videotaped into 2 formats: words and signs. For words, a series of slides of printed words was displayed with each slide on for 3 seconds followed by a 3 second blank interval. For signs, a trained interpreter signed the items. She was cued to present a sign at the beginning of each 6 second interval. She remained on the screen for 3 seconds followed by a 3 second blank interval.

Experimental design and procedure. Different groups of subjects were tested under 4 conditions of the experiment. In each condition, each subject was given a one-trial learning task. He/she was presented with a videotaped list of 36 items where each item remained on the screen for 3 seconds followed by a 3-second blank interval. Each was then given a 5 minute distractor task in which he/she searched for a particular number in a random number table. This task was followed by a 5 minute free recall test. The four different conditions were created by varying the mode of presentation with the mode of retrieval. Thus the conditions were: 1) Sign-Sign, 2) Sign-Word, 3) Word-Sign, and 4) Word-Word. Each subject was tested individually in a 1 hour session. Each was told which condition he/she would receive and was given standard free recall instructions. The deaf students were instructed by an interpreter who knew ASL. In the Word-Word and the Sign-Word conditions, the subjects wrote down their responses. In the Word-Sign and the Sign-Sign conditions the subjects

signed their responses which were recorded by the interpreter or the experimenter as well as videotaped. Later the videotapes were reviewed and the responses were recorded by another interpreter to make sure that the subjects' signs were properly recorded. In the recall test, the subjects were encouraged to try more if they wanted to quit before the 5 minutes were up. The interpreters were given the background information questionnaire before the experiment began. All subjects were debriefed after the experiment.

RESULTS

A preliminary analysis of variance of the data showed no sex differences. Hence the data was collapsed across sex and a 3-way analysis of variance of the data was carried out (Groups X Conditions X Recall of high and low imagery items). Raw scores indicating the number of high and low imagery items recalled by each subject were used. There were significant main effects for Groups ($F:22.90$, df: 1,72, $p < .001$) and for imagery ($F:28.59$, df: 1,72, $p < .001$). The Groups main effect indicated that the overall recall performance of the hearing (M:14.55, s.d.:4.54) was superior to that of deaf students (M:10.47, sd:2.87). The main effect for imagery indicated that the recall was generally better for high imagery items (M:6.96, s.d.2.69) than for low imagery items (M:5.55, s.d.:2.38). There was a significant imagery by conditions interaction ($F:8.25$ df:3,72 $p < .001$). For both groups the recall of high and low imagery items was different across conditions (see table 2). Post hoc comparisons of groups showed that the Word-Sign condition was significantly different from all the other conditions (see figure 1). The other 3 conditions were not different from each other. Furthermore, the differences between recall of high and low imagery items were significantly different from zero for the

Sign-Sign, the Sign-Word, and the Word-Word conditions showing the facilitatory effect of imagery while the difference was non-significant for the Word-Sign condition.

The above analysis revealed a difference in the probability of recall of high and low imagery nouns when an equal number of each were presented during the learning trials. There is another type of analysis that can be carried out on the data which would assess the probability of recall of high and low imagery nouns given the total number of items recalled. This measure allows us to test for the relative magnitude of high and low imagery difference in recall after adjusting for individual differences in the total number of words recalled or for capacity differences in processing and/or retrieving information. Since there is an overall performance difference between deaf and hearing subjects it was considered worthwhile to determine whether the relative magnitude of the facilitatory effect of imagery differs for deaf and hearing subjects after controlling for the differences in the absolute amount of items recalled. To test this hypothesis, the individual raw scores were converted to percentage scores by the formulae $\left(\frac{H}{H+L} \times 100\right)$ for high imagery items and $\left(\frac{L}{H+L} \times 100\right)$ for low imagery items.

A three way analysis of variance of the data (Groups x Condition x % Recall for H and L imagery items) showed that as before there was a significant main effect for Imagery ($F:22.72$; df: 1,72; $p < .001$) and a significant interaction between Imagery and Conditions ($F:6.16$; df:3,72; $p < .001$). The Imagery main effect was obtained because in general more high imagery items were remembered (M:55.80%; s.d.:12.1%) than low imagery items (M:44.15%; s.d.:12.09%). Post hoc comparisons revealed that the significant interaction between Imagery and Conditions was due to the recall of high and low imagery items in the Word-Sign condition which was significantly different from the other 3 conditions. The three conditions

did not differ from each (see Table 2 and Figure 2). Moreover, the Simple effects analyses showed that the differences between the % score for the high and low imagery items in the Sign-Sign, the Word-Word and the Sign-Word conditions were significantly different from zero showing a facilitatory effect of imagery while in the Word-Sign condition the difference was not different from zero and hence no facilitatory effect of imagery occurred.

The Word-Sign condition thus is somehow different from the other 3. There were 4 words in the list all of which had low imagery values which were considered a little difficult to translate accurately into signs by our interpreters who selected the items and by some of our subjects. These words were namely: discovery, disease, pressure and position. It was reasoned that since a good sign-match is hard to find for these low imagery words the subjects in the Word-Sign condition may have tried harder to remember these and thus the high-low imagery difference in recall may have disappeared. If this is the case, then the recall pattern for these 4 words in the Word-Sign condition should differ from that obtained in the other 3 conditions. A chi-square test revealed that there was no significant difference between the 4 conditions (X^2:9.34; df:9, n.s.).

DISCUSSION

The results of this experiment showed that there was an overall difference in the recall performance of hearing and deaf subjects, with hearing subjects doing better than deaf subjects. This finding is consistent with previous studies (Bonvillian, Note, 4: Conlin & Paivio, 1975), and is not surprising given the differences in education, age and experience of our hearing and deaf samples.

Apart from the main effect there were not significant interactions by groups (Imagery X Groups or Conditions X Groups or Imagery X Conditions X Groups). These findings suggest that when deaf and hearing subjects are reasonably fluent in both languages, there are not significant differences in their processing and retrieving information from those languages. Taken together with the finding that there was no Conditions main effect, this suggests that sign language is probably processed in a way similar to English language. These results are not consistent with the results of Siple, Fischer and Bellugi (1977) who found that the deaf native speakers of sign language showed better recognition performance when signs were used as presentation or retrieval cues. First, the discrepancy may be due to the different measure of retrieval i.e. recall employed in our experiment. Secondly, the discrepancy may be because Siple et al. did not control for the English language competence of their deaf subjects or have a control group of hearing signers. Thus it is possible that their deaf subjects had sign language as their dominant language and varied in their English language competence and thus benefitted in general when signs were used as cues. Our results indicate that when proficiency in Sign and English is high, signs do not seem to be inherently different than words. Thus the visual-spatial nature of signs does not seem to cause easier encoding by the imagery and/or verbal systems.

The main effects of imagery found using raw scores as well as Z scores indicated that more high imagery items were remembered than low imagery items across conditions and groups. This result confirmed Conlin and Paivio's (1975) results with English words where they used only raw scores. It further showed that the effect occurs when the information is presented in signs. Thus it can be inferred that signs are processed in a way similar to words. Our finding is in line with the current data which show that sign language is a language with its own grammar (Bellugi and Klima, 1975; Siple, 1978).

The significant interaction between Imagery and Conditions is extremely intriguing since it showed that in the Word-Sign condition, the facilitatory effect of imagery was not obtained. In all the other conditions high imagery items were remembered better than low imagery items. Since there was no Conditions main effect, a simple explanation that the Word-Sign condition was more difficult than other conditions is not supported. The total number of items recalled in each condition were not different from each other. Another possible explanation is that since English is a second language for deaf students, translating from it into Sign requires special effort and hence the imagery effect disappeared. This explanation can be ruled out since there were no significant interactions with groups which indicated that for hearing people who were presumably fluent in English, the same effect occurred in the Word-Sign condition. A third possibility is that when translating from one language to another or from one mode to another, imagery effects do not occur. This possibility can also be ruled out since in the Sign-Word condition the high imagery items were remembered better than the low imagery items. We have already tested and ruled out the possibility that the peculiarity of some test items resulted in the unusual effect in the Word-Sign condition.

Thus it seems clear that the results in the Word-Sign condition were due to the nature of the condition itself. In translating from English to Sign, it seems that both hearing and deaf subjects employed a strategy different from the strategies used in the other conditions. Though it is not possible to explain the effect from our data, we will offer some speculations about it which can be tested by further experiments.

One speculation is that while mapping from English on to Sign it is harder to find an adequate match for low imagery words. High imagery words usually refer to concrete items which have direct referents in reality

while low imagery items usually represent abstract concepts which may or may not have adequate referents in reality. Thus the probability that precise terms exist to represent high imagery items in both English and Sign is greater since these referents will be encountered in the real world and terms are needed to describe them. There may be more variation in representing low imagery-abstract concepts. The terms in one language conveying subtle shades of meaning may not have identical counterparts in another language. Anyone who is bilingual and has tried to translate his/her favorite poem into another language will agree with this suggestion. We further suggest that it is possible that the English language has more such separate terms to represent a generic concept than Sign language. Thus a perfect match for some low imagery words is difficult though generic low imagery terms in English and Sign can be matched. It should be made clear here that the above suggestion does not presuppose that adequate translation from English to Sign is not possible or that the Sign language is 'concrete' i.e. unable to handle abstract concepts. The scope of the suggestion is only to point out that there may not be separate individual signs for all the English words and hence a one-to-one match for low imagery words may not be possible. In our experiment the presentation list consists of individual terms not connected with each other. It is possible that the orthographic and/or phonetic nature of English allows for the presentation of terms depicting several shades of meaning in isolation and still be identified. Perhaps in Sign language contextual cues from the sentence or sentences in which a sign is embedded, are necessary to make the subtle distinctions in the meaning of that sign. Perhaps, the presence of the context changes the nature of the sign itself thus allowing it to represent different shades of meaning. Since the linguistic analyses of sign language has not yet identified all the mechanisms with which meaning is represented, it is not

clear how exactly meaning gets translated from English to Sign.

If we entertain the above possibilities that in general it is hard to find adequate matches across languages for some low imagery terms and that the English language has more individual terms to represent a generic concept than Sign, we can speculate why the imagery effect disappeared only in the Word-Sign condition and not in the Sign-Word condition. We can discuss the Sign-Sign and the Word-Word condition with the statement that an imagery strategy operated when the processes occurred within the same language and thus involved no translation effort. In the Sign-Word condition, when individual signs representing low imagery generic concepts were presented, finding their match in English was probably as easy as finding the matches for high imagery signs. Since the translating effort was minimal, the imagery strategy could be used and the facilitatory effect of imagery emerged. To give an example in the Sign-Word condition the sign for 'find' can be quickly translated as 'find' in English. In the Word-Sign condition, however, when the word 'discovery' is presented in English, it takes more effort to come up with the sign 'find'. Thus in the Word-Sign condnition, more effort was probably involved in finding an adequate match by translations. Subjects probably had to resort to a semantic strategy by which they analyzed and compared the semantic features of words and found generic signs which overlap those features. It is, therefore, possible that subjects might have switched to a general strategy of semantic feature analyses instead of an imagery strategy and thus high imagery items lost their advantage over low imagery items.

A reaction time study which measures the amount of time taken to translate is necessary to see if the above hypotheses can be supported. If in general, translating low imagery items is difficult as we suggest, low imagery items should require more time than high imagery items to translate

from English to Sign. If our hypothesis about the switch in strategies is correct, then it should take longer to translate low imagery items from English to Sign than from Sign to English. Only further research will illuminate why the Word-Sign condition led to a disappearance of imagery effect for both deaf and hearing subjects.

In conclusion, the results of the study showed that there was an overall performance difference in a recall task between deaf and hearing students. There was an overall imagery effect which showed that imagery facilitated memory for words and signs for both deaf and hearing students. This facilitatory effect was, however, absent in the Word-Sign condition for both groups. The absence of Conditions main effect and interactions with deaf and hearing groups suggested that English and Sign were processed in a similar fashion.

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FOOTNOTE

This research was conducted in the course of an agreement with the U.S. Department of Health, Education and Welfare. This paper is based on a part of the dissertation which will be submitted to the University of Rochester.

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TABLE 1

THE AVERAGE SCORES OF DEAF SUBJECTS ON 6 TESTS

	TESTS[A]	DEAF SUBJECTS	
		M	SD
1.	WRITE	8.01	.95
2.	READ	8.94	1.39
3.	MRT	83.53	8.07
4.	SRE	35.30	14.47
5.	ABT	31.70	14.61
6.	PTA	100.92	18.25

[A] WRITE REFERS TO THE NTID WRITING TEST (CRANDALL, NOTE, 3). MAXIMUM SCORE IS 10.
READ REFERS TO THE CALIFORNIA READING COMPREHENSION TEST (TIEGS & CLARK, 1963). MAXIMUM SCORE IS 12.
MRT REFERS TO THE MANUAL RECEPTION TEST (JOHNSON, 1976). MAXIMUM SCORE IS 100.
SRE REFERS TO THE SPATIAL RELATIONS TEST AND ABT REFERS TO THE ABSTRACT REASONING TEST (BENNETT, SEASHORE, & WESMAN, 1966). MAXIMUM SCORES ARE 60 FOR SRE AND 50 FOR ABT.
PTA REFERS TO THE PURE TONE AVERAGE IN THE BETTER EAR AT 500-1000-2000 Hz (ANSI, 1969).

TABLE 2

THE AVERAGE RECALL PERFORMANCE ACROSS 4 CONDITIONS COLLAPSED OVER DEAF AND HEARING SUBJECTS.

ITEMS[A] RECALLED	SIGN-SIGN M	SIGN-SIGN SD	SIGN-WORD M	SIGN-WORD SD	WORD-SIGN M	WORD-SIGN SD	WORD-WORD M	WORD-WORD SD
TOTAL	13.45	3.99	13.25	3.37	12.10	3.60	11.25	5.76
HI	8.05	2.62	7.60	2.01	5.65	2.01	6.55	3.39
LI	5.40	2.01	5.65	2.18	6.45	2.26	4.70	2.83
HI-LI	2.65	2.43	1.95	2.50	-.8	2.31	1.85	2.43
% HI	59.95	10.77	58.05	10.42	46.85	11.01	58.35	12.17
% LI	39.55	11.05	42.25	9.89	53.15	11.01	41.65	12.17
% HI-LI	20.40	21.70	15.80	20.28	-5.5	22.25	16.7	24.35
ERRORS	1.30	2.10	1.55	1.82	1.95	3.55	2.1	2.63

[A] HI REFERS TO HIGH IMAGERY ITEMS.

LI REFERS TO LOW IMAGERY ITEMS.

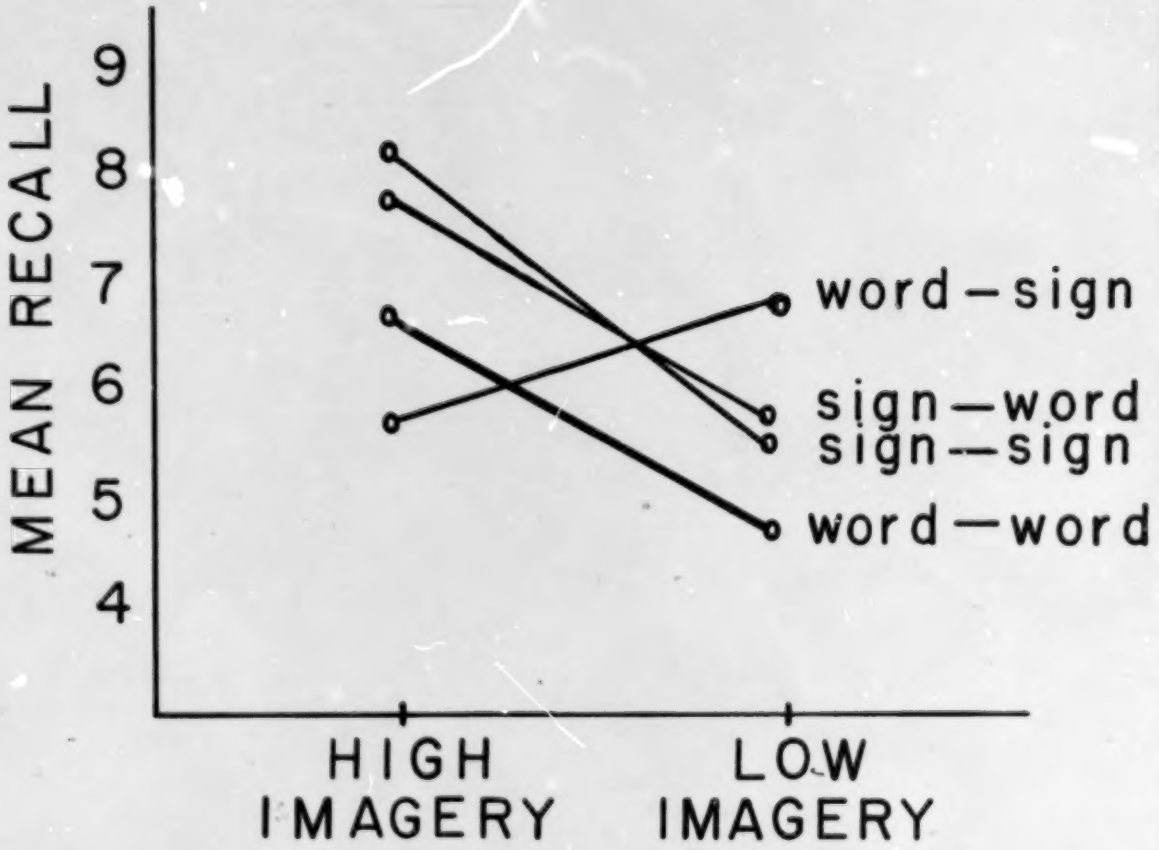

Figure 1. Mean recall for high and low imagery items in 4 conditions

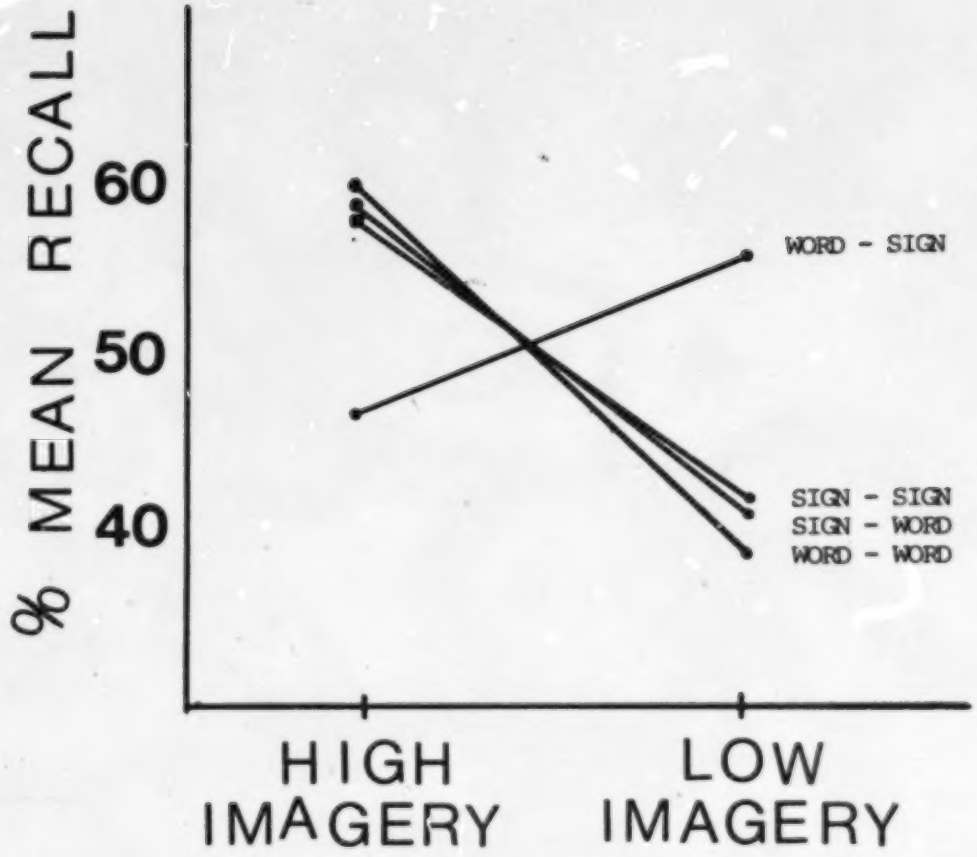

FIGURE 2. MEAN % RECALL FOR HIGH AND LOW IMAGERY WORDS FOR FOUR CONDITIONS.